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The Editor's Page

INTERESTING, if not significant, is the fact that both of this year's medallists of The Textile Institute, Manchester, Eng., are physicists and received their awards for noteworthy applications of that science in textile research and technology. F. P. Slater, who was awarded the Institute medal, is head of the experimental department of the Fine Cotton Spinners and Doublers Association, and chairman of the Institute's Unification of Testing Methods Committee. Henry John Woods, the Warner Medallist, is an honors man in mathematics and natural science of Brasenose College, Oxford, and has been working recently at Leeds University with Dr. W. T. Astbury in the Textile Physics Laboratory.

* * *

PRESIDENT FRANK NASMITH of The Textile Institute, Manchester, Eng., summarizes in a statement to the *Textile Recorder* the results of the conference which he and J. R. S. Goodall had with various textile organizations, on their recent visit to this country and Canada. The statement is as follows: "The recent visit of Mr. J. R. S. Goodall and myself to America and Canada leads us to believe that at no distant date we shall be enjoying greater co-operation with the textile societies of the United States, and that in Canada we shall have a very close liaison with the new textile associations that are being formed."

* * *

PRESIDENT NASMITH'S STATEMENT indicates that he has discovered the logical basis of more effective co-operation between his Institute and the textile societies in this country, and that is through a closer liaison with Canadian textile societies, or possibly through a Canadian section of the Institute. Unquestionably the education and standardization programs of The Textile Institute, which, rather than scientific or technical research, form its principal activities, are more applicable to Canadian conditions than to those existing in this country, and of greater potential value to the Canadian textile industry. Between textile societies in this country and Canada there exists a generous spirit of co-operation. Moreover, their technical problems are strikingly similar, and there is a mutual understanding of each other's failings and virtues that is an essential basis of resultful co-operative effort.

* * *

A LARGE PARTY of textile manufacturers from Germany and other European countries is due to arrive in New York City on the S. S. Deutschland Aug. 5 for a two weeks' study tour. The party was organized and is directed by Marcel Melliand, editor and publisher of *Melliand Textilberichte*, Heidelberg, Germany, and Prof. Dr. Ing. O. Mecheels, president, International Association of Textile Chemists and Colorists. Listed on the program are visits to many textile and other mills, and institutional and governmental laboratories. The evening of Aug. 16 the party will attend a dinner and conference in New York City with the American Association of Textile Chemists and Colorists and the American Association of Textile

Technologists. Among others listed to speak at this function are Werner von Bergen, Dr. Erwin J. Saxl and Prof. Dr. Egon Elöd. The latter is an authority on wool manufacturing technique and textile drying, and will speak in English. The tour includes visits at and near Boston, Albany, Detroit, Chicago, Pittsburgh, Washington and Philadelphia, as well as New York City.

* * *

IN this issue will be found the third of a series of papers descriptive of the work and findings of the Federal-State cotton research program sponsored and conducted by several bureaus of the Department of Agriculture. It is by Carl M. Conrad and Earl E. Berkley and its title is adequately descriptive of its coverage: "Some Possibilities and Limitations of X-ray Methods for Measuring the Strength of Raw Cotton." In common with work of a similar character by other scientists, it has not progressed far enough thus far to demonstrate conclusively its use for strength measurements, but the Conrad-Berkley paper indicates interesting possibilities. Unintentionally, this series of papers was referred to in the July issue as containing only three and omitting reference to the paper appearing in this issue. A paper by Dr. Enoch Karrer and T. L. W. Bailey, Jr., on "Geometric Fineness and Associated Cross-Sectional Features of Cotton Fibres" will conclude the series in the September issue. These papers are descriptive of a part of the program of work of what is known as the Cotton Utility and Standards Research Section of the Bureaus of Plant Industry and of Agricultural Economics under the direction of Dr. Robert W. Webb, principal cotton technologist of the Division of Cotton Marketing.

* * *

Research: Plain or Fancy

"THERE is only one real way to solve the textile problem—and that is by increasing the market for textiles. And one of the chief ways to bring that about is through research—both technical and economic. Research of a really fundamental nature.

"There is, or should be, no quarrel between those who believe in that sort of research and those who are ardent supporters of so-called practical research. Both are indispensable but they are quite distinct. And, incidentally, some of the most fundamental researches in other industries have proved to be extremely 'practical'—if dollars-and-cents results may be used as a gauge for practicality."—*Textile World*, July, 1938.

* * *

Science and Empiricism

Synthetic yarns of cellulosic or non-cellulosic bases, with the elasticity and strength in fine deniers requisite for full-fashioned hosiery and other materials, are said to be the subject of research by several domestic rayon manufacturers.

* * *

New synthetic yarns of domestic manufacture include "Teca," an acetate rayon staple fibre having a permanent crimp, the product of Eastman Acetate Co.; also "No. 33 Acetate," a continuous filament yarn having certain filaments cut at regular intervals, thus simulating the effect and feel of a staple rayon yarn, the latter is the product of Tubize Chatillon Corp.

Lactofil is Holland's answer to Italy's Lanital. Both synthetic products have similar chemical and physical properties, it is reported, but the former is produced by Algemeene Kunstyijde Uine, Nijverdal, directly from skim milk, and not from casein. For a country faced with the problem of disposing of immense quantities of skim milk, Lactofil manufacture is a logical solution; but for "synthetic wool" production in a country that must import a large part of its raw material the Ferretti process using a casein base seems more practical, or a process utilizing either animal or vegetable casein.

* * *

"Whale blubber, when dried, can be carded and spun," according to "Pedlar" in *The Wool Record and Textile World.* Evidently in a somewhat cynical mood, he suggests that whale blubber yarns might be used for such materials as Harris Tweeds. "It would be a fairly safe assumption," he writes, "that, unless the chemists find a means of de-scenting it, a certain fishy smell will be retained, and if a column of smoke were to be forced on the yarn, or even on the piece, a tolerable imitation of the rich scent of Harris Tweed after a day in the rain would be obtained. I understand that the difference between the genuine Harris of the Outer Hebrides and that of the Heavy Woollen District of the West Riding is not so much geographical as nasal, and it is possible that a Blubber Tweed will remedy the defect."

* * *

This is Co-operation

"One of the best examples of co-operation which the textile industry has ever offered is that which has been responsible for the report on Vertical Integration in the Textile Industries, reviewed on page 41 of this issue. Into this result went the initiative of the U. S. Institute for Textile Research, whose Committee on Economic Research first recommended the study; the financial support of the Textile Foundation; the active work of the Industrial Research Department of the Wharton School of Commerce and Finance, University of Pennsylvania; the assistance of the heads of all the leading textile associations, and the co-operation of hundreds of textile concerns which supplied the necessary information.

"The interlocking set-up by which all these groups worked together toward a common end may well be emulated in the planning of future research projects in the industry."—Editorial, *Textile World,* July 1938.

Dr. Charles Holmes Herty

DR. CHARLES HOLMES HERTY died suddenly in Savannah, Ga., July 27, in his 71st year. He had entered a hospital in that city some ten days previously for a check up and rest. Apparently his heart had been seriously weakened by his arduous research work in connection with broadened application of his process of producing paper pulp from slash pine and other Southern woods. He had been engaged in this research and its commercial application since 1930, and it had resulted in the establishment

(*Continued on page 363.*)

Some Possibilities and Limitations of X-Ray Methods for Measuring the Strength of Raw Cotton*

By CARL M. CONRAD and EARL E. BERKLEY†

Introduction

DURING recent months frequent questions have come to the Cotton Technological Laboratory regarding the classification of cotton by X-ray methods. Among the questions have been such as these: Can the X-ray method be used to classify cotton? Have you found the X-ray method satisfactory? How accurately does the X-ray method predict the spinning value of the cotton? How much does the equipment cost? How rapid is the method? In view of the considerable interest in this new technique, and the general lack of familiarity with it on the part of many in the cotton industry, it has seemed worthwhile to make a few statements at this time, even though the investigations have not, thus far, advanced to a stage where final conclusions can be drawn.

Before attempting to answer any of the above questions, it may be profitable first to trace a few ideas that have led more or less naturally up to the present investigations.

Wall Structure of the Cotton Fibre

Since about 1920 (*6*, p. 613 *et seq.*) it has been known that cellulose in natural vegetable fibres, such as cotton, flax, hemp, etc., exists to a large extent, if not entirely, in the form of tiny elongated crystals, so small that they have never been clearly discerned even under the highest powers of the microscope. However, they do show the properties of crystalline materials under the microscope. These minute crystals, furthermore, are not lying helter-skelter but are arranged in a more or less regular pattern, the degree of regularity varying a great deal with variety of fibre, from fibre to fibre in the same variety, and even in the same fibre point to point along the axis.

The regularity of arrangement of these minute crystals, generally called "crystallites," in most natural vegetable fibres takes on the form of long strands or "fibrils," which in turn are arranged, mostly parallel, into a more or less spiral structure. For example, Morey[9] found the average angle of spiral to the fibre axis in hemp to be practically zero; in ramie 3.5°, and in flax 5.5°. In cotton fibres, on the other hand, the angle of

* These studies are being conducted through co-operation between the Bureaus of Plant Industry and Agricultural Economics as a part of the program of work of the Cotton Utility and Standards Research Section under general direction of Robert W. Webb.

† Dr. Conrad is Senior Cotton Technologist, and Dr. Berkley Associate Cotton Technologist, Bureaus of Agricultural Economics and Plant Industry, co-operating, U. S. Department of Agriculture.

spiral was found to be much larger and extremely variable. The spiral structure in cotton fibres has been extensively studied under the microscope by Balls,[2] Denham[4] and Anderson and Kerr[1] and the results of the latter study are embodied in a model which is reproduced here with the authors' permission (Fig. 1). It is seen that the direction of the fibrils represented by the visible striations, are variously oriented in the successive layers, being almost perpendicular to the fibre axis in the outer layer of cellulose (primary wall) and at a smaller angle with frequently reversing direction in the subsequent inner layers (secondary wall).

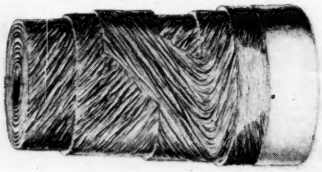

FIG. 1. This diagram of a mature cotton fibre indicates the approximately 70° spiral of the fibrils in the inner layers of the primary wall, and the steeper, occasionally reversing, spiral of the fibrils in the layers of the secondary walls. Courtesy of Anderson and Kerr.

Principle of the X-ray Technique

When a fine parallel beam of X-rays is passed through a fibre (or better, a bundle of parallel fibres) perpendicular to the long axis, most of the rays pass straight through. If a photographic plate is properly located back of the bundle so as to receive the rays, it will, after development, show at this place a small black spot. However, at the same time a small portion of the X-ray beam is refracted or deflected away from the main beam by the reflecting planes of the tiny crystals and falls in the form of spots or arcs away from the central spot (Fig. 2). If the fibrils of the individual fibres have no spiral, or only a very small angle of spiral, as, for example, in ramie

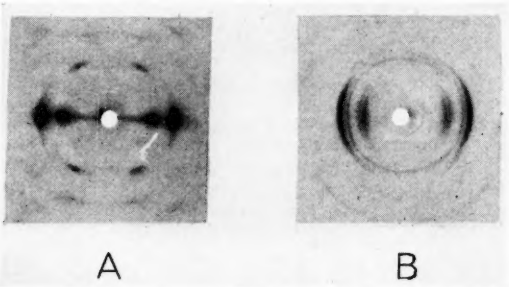

FIG. 2. X-ray diffraction patterns obtained from bundles of paralleled cellulose fibres. Ramie fibres, with very slight angle of fibril spiral about the fibre axis give spots or very short arcs, (A), while cotton fibres with much greater angle of fibril spiral give pronounced arcs (B).

(Fig. 2A) the refracted X-rays give spots. On the other hand if the fibres possess a pronounced spiral structure, as in the case of cotton fibres (Fig. 2B) the diffracted X-rays will give distorted spots, which fall in the form of arcs of a circle. As an extreme case, if the tiny crystals had no regular arrangement but were oriented to an equal extent in all directions, the diffracted X-rays would give symmetrical concentric circles. The latter type of X-ray pattern is obtained from certain synthetic cellulose products such as cellophane sheet, when the X-ray beam is passed through the sheet perpendicularly to the plane of the sheet. Thus the X-ray pattern shows whether or not the tiny crystals of the fibres are regularly arranged with respect to each other and with respect to the axis of the fibre; and by quantitatively measuring the length of the arc it is possible to obtain a very good measure of the degree to which the crystallites deviate on the average from perfect alignment with the fibre axis. Techniques for measuring the length of the arcs have been discussed by Sisson and Clark,[12] and the results of our application of this technique to the measurement of the strength of raw cottons have been described by Berkley [3] and by Sisson.[13]

Briefly, the method of measuring the diffraction patterns may be visualized by reference to Fig. 3. This figure shows at the top three X-ray

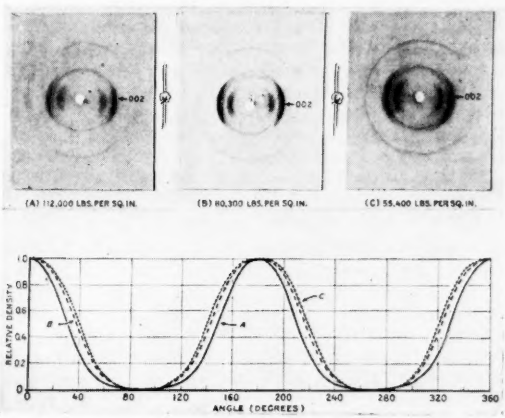

FIG. 3. X-ray diffraction patterns from three cottons giving Chandler strength values in pounds per square inch as follows: (A) 112,000; (B) 80,300; and (C) 55,400; and a chart showing the angles of equal relative density for the 002 arcs for each of the patterns.

diffraction patterns, each of a cotton of different strength as measured by the improved Chandler method. The pattern at the left (Fig. 3A) was obtained from a bundle of Sea Island fibres giving a Chandler strength of 112,000 pounds per square inch. The pattern in the center (Fig. 3B) was obtained from an upland cotton giving a Chandler strength of 80,300 pounds per square inch. The pattern at the right (Fig. 3C) was obtained from an upland cotton giving a Chandler strength of 55,400 pounds per square inch.

While it may not be evident from casual observation that the lengths of the arcs differ in the three patterns, it will be observed on closer inspection that the arcs of the patterns decrease from right to left. Accurate measurement with a sensitive instrument called a microphotometer [3] permits fine distinctions to be made. Curves of the photometer readings around the 002 ring are shown below the patterns, and by reference to these it will be seen that at any given relative density the curve corresponding to pattern A has the narrowest loop beneath the curve, while that corresponding to pattern C has the widest loop. The intermediate curve has a loop of intermediate width. The width of the loop at some definite height measured in angular degrees thus becomes a measure of the length of the diffraction arc.

Spirality Probably a Source of Weakness

The relation between the arrangement or common orientation of the tiny crystals with respect to the fibre axis and the strength of the fibre should next be considered. Unless such orientation bears some definite relationship to strength, its measurement by X-ray or any other means will be of no assistance to us in solving our problem. Fortunately, there seems to be considerable evidence, much of which we shall not go into here, to indicate that in cellulose fibres perfect alignment of the crystallites with the long axis of the fibre is the ideal arrangement to give maximum strength. As evidence in favor of this general proposition may be tabulated the strength of several textile fibres as given by Mark,[8] together with the angles of spiral as given by Morey.[9]

Fibre	Average Angle of Spiral Degrees	Average Strength Kgs. per sq. mm.
Hemp	0	80–92
Ramie	3.5	70–80
Flax	5.5	69–110
Cotton	up to 50.0	28–44

It will be seen here that the stronger fibres have the smaller angle of spiral with respect to the long axis of the fibre.

Several years ago in the cotton fibre laboratories of the Bureau of Agricultural Economics some measurements were made of the strength of bundles of cotton and of rayon fibres and of individual rayon fibres, after inserting different degrees of twist.‡ The results recorded in Tables 1 and 2 respectively, and Fig. 4, show the extent to which the insertion of different degrees of twist result in lower strengths. In the case of the Chandler bundles, prepared from cotton (Table 1) with 2.29 turns per inch corresponding to an estimated twist multiplier of 3.24,‖ the reduction in strength amounted to 3.35% of the original strength, whereas the insertion of 11.63 turns per inch, corresponding to the relatively high twist multiplier of 16.45, resulted in a reduction to less than 50% of the original strength.

While the rayon Chandler bundles (Table 1) showed very definite reductions in strength at a twist multiplier of only 2.19, the reductions at higher twists did not equal those of the cotton bundles; nor could bundles of as great twist, as in the case of the cotton, be prepared because of break-

‡ Credit is due to Mr. H. B. Richardson for making these tests.

‖ Twist multiplier is the name of a factor relating the number of turns per inch to the square root of the count, or diameter, of a yarn or fibre; comparable twists for different counts or diameters require that the twist multiplier be the same.

TABLE 1

Strength of Bundles of Cotton and Rayon Without and With Varying Degrees of Twist

Kind of Fibre	No. Bundles Observed	Twist Inserted		Strength	Loss of Strength
		Turns per in.	Twist Multiplier	Lbs. per sq.in.	Percent
Cotton	10	0	0	97,000	0
	2	2.29	3.24	93,750	3.35
	2	4.92	6.95	85,100	12.27
	2	8.00	11.30	68,950	28.93
	2	11.63	16.45	46,550	50.95
Rayon	10	0	0	29,200	0
	10	1.60	2.19	27,900	4.45
	10	3.20	4.37	26,500	9.24
	10	5.33	7.68	27,000	7.54
	6	8.00	12.21	*	*

* Bundles could not be wrapped without breaking in the wrapping jaws

age during wrapping. On the other hand, the individual rayon fibres (Table 2) having a denier of about 1.45 gave reductions in breaking load greater than those corresponding to the same twist multiplier of the cotton bundles. At 150 turns per inch, corresponding to an estimated twist multiplier of 2.37, a reduction of only 0.41% was observed, but at 400 turns per inch, corresponding to a twist multiplier of 7.95, the reduction on the basis of the original breaking load amounted to 38.8%.

The results of these experiments merely emphasize a phenomenon that is well known in the textile manufacturing industry, namely, that excessive twist in yarns results in a lowered yarn strength. The same type of phenomena has been reported recently for cotton fibres by Navkal and Ahmad,[10] although these investigators did not go to nearly as high twist multipliers. They worked at 63.5, 127 and 254 turns per inch, corresponding to the

TABLE 2

Mean Breaking Load of Individual Rayon Fibres Tested Without Twist and With Different Degrees of Twist

Twist Inserted		Fibres Observed	Mean Breaking Load	Loss of Strength
Absolute	Relative			
Turns per inch	Twist Multiplier	Number	Grams	Percent
0	0	18	2.956	0
150	2.37	18	2.944	0.41
300	5.02	18	2.506	15.25
400	7.95	18	1.811	38.80

relatively low estimated twist multipliers of 1.05 to a maximum of 5.77 depending on the fibre count. The reductions in breaking loads for the higher twist multipliers varied from 5.1 to 24.0% although in the case of one cotton no reduction was recorded at a twist multiplier of 4.22. In one case a twist multiplier of only 2.20 resulted in a reduction of 2.9% in the breaking load.

Let us consider further for a moment a cotton fibre which, we shall assume, has an approximately average weight per inch of 5.0 micrograms and a corresponding perimeter of cross-section of 44 microns. Now referring again to the model of fibre structure presented by Anderson and Kerr on the basis of their microscopic researches (Fig. 1), we can ascertain that the spiral angle of the secondary thickening amounts to approximately 45°. If we compute the fibre count from its weight per inch and also the turns per inch for a 45° spiral, we shall find that this corresponds to a twist multiplier of 10.5, or, on the basis of our cotton bundles, this should result in a reduction in strength of over 25% from an idealized fibre without spiral structure. Even if we assume that the mean angle of twist is only 30° instead of 45° we shall still compute a twist multiplier of 6.1 which, as we have seen above in the case of artificially twisted fibres,

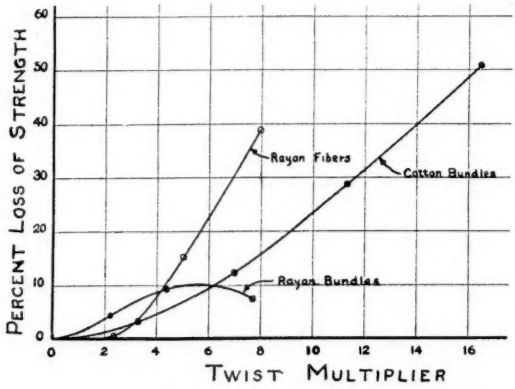

FIG. 4. Percent loss of strength of bundles of cotton and rayon fibres and of individual rayon fibres when twisted to comparable degrees as indicated by the twist multiplier factor.

has resulted in reductions of 10–25% in strength as compared with the fibres before twisting.

It is, of course, not certain that a definite twist inserted artificially will have the same degree of influence on strength as that occurring naturally. In the latter case there may be a certain amount of binding between the units of a fibre due to the continuous matrix which would not occur in artificially twisted fibres or bundles. Whether such differences as may exist are fundamental, remains to be demonstrated. Nevertheless, if natural twist is as effective in lowering strength as artificially induced twist, the natural twist in cotton fibres is of such order of magnitude as seriously to influence their natural potential strength. Furthermore, our knowledge of the great variability of twist in the successive wall layers, along each individual fibre, and from fibre to fibre offers a plausible explanation, and satisfactory basis for understanding the great variation of strength in raw cotton. Also, since the angle of twist describes to a large

degree, although probably not entirely, the direction of the common orientation of the invisible crystals of the fibre, and since, as we have shown, the varying degrees of twist together with any other deviations of alignment can be recorded on the X-ray diffraction pattern, a theoretical basis is provided for application of an X-ray technique to the measurement of the strength of raw cotton.

Some Advantages and Limitations of the X-ray Method

Having now laid a background for our understanding of the X-ray technique, we are in a position to consider some of its relative merits and limitations. In doing this we shall naturally make comparisons with the improved Chandler method,[11] although a modification of the bundle method, worked out recently by Grimes,[5] is claimed to give almost equal precision. The bundle methods are, of course, the only ones in use which take into account the fibre cross-sectional areas and which are, therefore, of any practical significance for measuring the strength of raw cotton.

Precision.—Probably one of the first questions that should be answered is, at its present stage of development, how precisely can raw cotton strength

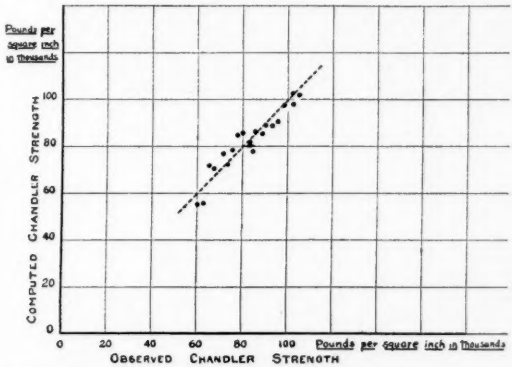

FIG. 5. Relation of tensile strength values computed from X-ray diffraction pattern measurements and observed Chandler strength values.

be estimated by the X-ray method. Although a high degree of precision is doubtlessly not required in the industry, nevertheless, unless the precision comes up to a certain standard the steps of classifications or discrimination will be too wide for practicability.

Considering the results thus far attained with the X-ray technique on sound cotton, under the best conditions which it has been possible to provide and from a limited number of observations, it appears that the precision of this new method approaches but does not quite equal that of the improved Chandler method. Thus in 19 different cottons it has been possible, using only a single bundle in each case for the X-ray pattern, to obtain a coefficient of correlation of 0.954 between the diffraction arc angle and Chandler bundle strength (Fig. 5). With the aid of a regression formula

based on this relationship the Chandler bundle strength was computed from the diffraction arc angle and a standard error of only 4,100 pounds per square inch was found. This standard error includes, of course, the standard error of the average of 10 Chandler bundles or about 1,000 pounds per square inch. After making a correction for this, we arrive at an estimated standard error for the X-ray method of 3,980 pounds per square inch. On the basis of the average strength of 82,930 pounds per square inch for the 19 cottons this amounts to an average error of 4.8%. The standard error of the strength determined on a single bundle by the Chandler method is about 3.32%. If we make duplicate X-ray patterns we can probably reduce our error of estimation to 3.40%. In the usual determination on 10 bundles by the latest Chandler procedure a precision of about 1.2% is attained.

Speed.—Speed of measurement is one of the most pressing needs in the field of cotton technology, today. The practical cotton manufacturer may well be skeptical of precise laboratory methods where the results are attained at the expense of an exorbitant amount of time and energy. The improved Chandler method, while meeting fairly well the requirements of precision, is still seriously handicapped by the time required to complete a single test. The slowness of this method constitutes one of the most pressing reasons for seeking other more rapid methods even at the expense of some precision, if need be. How rapid is the X-ray method and how does this compare with the best expectations of the Chandler procedure?

In considering the speed of a method two factors should be kept in mind. One is the speed that is attainable after a routine has been worked out and everything possible is done to conserve time between successive operations. In order to best attain this objective it is frequently desirable to carry a number of replications of the measurement or determination side by side; or perhaps the procedure can be divided into several major steps, each cared for by one or more persons. The other factor is the over-all time required for a complete result. Even though a setup might give on the average, say, 25 observations per day, it is easy to imagine a case where a week might be required from the beginning to the end of any one measurement or determination. How do the X-ray and Chandler methods compare in this respect?

On the basis of present observations it would appear that the best arrangements for carrying out the X-ray determinations would be to have about four technicians to each X-ray tube. Two would be required to comb, wrap and photograph the bundles while two more would measure the patterns with microphotometers. In this way the tube could be operated continuously throughout a working day to give in, say seven hours, about 36 patterns. If two patterns are taken for each cotton, the average number of samples that could be run per day is 18, or 4½ per person. In case the results for some particular cotton were desired in the shortest possible time, they could probably be obtained within a period of 5 to 6 hours.

In the Chandler procedure one man can so arrange his time as to work about equally effectively whether he works alone or in a group. However, it is desirable in practice to arrange the work from two or more technicians in order to eliminate personal errors. It is easily possible for three technicians to determine the strength on 4½ cottons per day, or in a rush, 6. Thus, the rate is about 1½ to a maximum of 2 cottons per day per technician. For a complete determination, including periods of air conditioning, approximately two days are required at the least. Thus, the X-ray method

at the present time may be considered under optimum conditions to be approximately twice as rapid as the Chandler method as now used, and to give results in about half the total time required for a Chandler measurement. It is hoped that further study will still further expedite the X-ray method.

General Applicability.—The X-ray technique has an especially advantageous feature in that it is equally applicable to all staple lengths and to all strengths and weaknesses of fibre. The Chandler procedure is limited in this respect. When the staple length of the cotton to be tested is as low as $^{15}/_{16}$ inch, difficulty is often experienced as a result of the bundle breaking during wrapping, and for the still shorter staples or very weak cottons, the bundles often cannot be wrapped at all. With strong cottons, on the other hand, difficulty is often experienced in that the bundles do not break properly but slip out of the breaking jaws, or only an outer ring of fibres break while the remainder slip.

Sensitivity to Slight Modifications.—The Chandler bundle method is very sensitive to slight modifications of technique.[11, p. 26] Upon certain occasions it has been impossible to bring two or more technicians to produce Chandler bundles having the same average strength; the averages would differ by amounts much greater than could be accounted for by the degree of precision of the method. Furthermore, it has been difficult, if not impossible in one or two instances, to locate the source of such discrepancies. How does the X-ray method stand in this respect?

The limited amount of data available does not yet permit a definite answer to this question. It is evident already that the density of the X-ray patterns is greatly altered by time of exposure to the X-ray beams, and conditions of development. Plans are under way to determine the extent of effect of such influences. In the meantime it may be stated that the absolute density of the different parts of the X-ray pattern increase to a large extent proportionally, and since the technique measures the angle corresponding to a fixed proportion of the difference between the maximum and minimum densities of a given arc, it follows that a change in absolute density of the negative has relatively slight effect on this angle. Exposure time can be controlled. Further, preliminary studies have indicated that corrections can be applied which largely remove the effects of slight uncontrolled variations in densities of pattern.

Preservation of Test Specimen.—The X-ray method is definitely superior to the Chandler method in that the specimen is preserved intact and can be stored away or retested if desired. If a Chandler bundle is broken in a faulty way, or there is question concerning the calibration of the testing machine, or the atmospheric conditions, etc., it is impossible to verify this on the original specimens. While ability to recheck the original specimen will not disclose errors from lack of true representation, it will thus permit many assurances to be obtained which are impossible under the Chandler technique.

Atmospheric Conditions.—The Chandler method, as is well known, is definitely sensitive to variations in atmospheric moisture. While the influence of atmospheric condition upon the X-ray method has not been studied as exhaustively as it is planned to do, preliminary results have not indicated much, if any, effect from this source. According to Mark,[7, p. 96] moisture content does not affect either the spacing or the intensity of the X-ray diagram of ramie fibres. Of course, ramie fibres show only a slight

twist of the fibrils, and it is just possible that the much higher twist in cotton fibres might lead to some influence from varying atmospheric humidity. Although atmospheric humidity undoubtedly influences the kinkiness, this can be controlled by a small tension on the fibres sufficient to remove it during the recording of the pattern.

Cost of Equipment and Operation.—The equipment required for the preparation of X-ray diffraction patterns consists of a specially designed X-ray tube with auxiliary equipment and controls, one or two sensitive microphotometers, and the facilities of a small dark room for photographic development of the X-ray films. The X-ray equipment may cost in the neighborhood of $2,500, and the microphotometers $200 to $300 each. The cost of the dark room and photographic facilities may vary greatly according to local conditions. If it is assumed that control of atmospheric conditions is unnecessary the initial cost is thus materially less than for the Chandler method, which requires, for practical operation, automatic control of atmospheric humidity, together with combing, wrapping, weighing and testing devices and machines. The cost of the latter may aggregate as much as $4,500 to $5,000, exclusive of the cost of adapting the room. The X-ray results used in the above computations of precision were obtained without any attempt being made to control the atmospheric humidity during X-raying. If control of the humidity should prove to be necessary the initial cost of the X-ray equipment would, of course, considerably exceed the cost of the Chandler equipment.

As to the cost of making the tests, it may be assumed that personnel of about equal calibre would be required for the X-ray and Chandler methods. Thus, for the Chandler method at least a supervisor should have scientific training and some experience with physical concepts and methods. The remainder of the personnel should be by nature careful but need not have very extensive scientific training. So, too, with the X-ray method; at least the supervisor should have fundamental training in the sciences bearing on and relating to the X-ray techniques. The remainder of the personnel need have no more than, perhaps, a high school training and a careful disposition. Since the X-ray technique is more rapid than the present Chandler technique, it follows that the operating cost of the X-ray test will be somewhat less than that of the Chandler test.

Relation of X-ray Patterns to Yarn Strength.—A method which gives a good degree of correlation between the lengths of the diffraction ares and the Chandler bundle strength may be expected to give a good correlation between the lengths of these ares and yarn strength, because of the correlation between Chandler strength and yarn strength. Such is found to be the case. In a study of the correlation between diffraction arc length and 60s skein strength of 19 cottons a correlation coefficient of 0.754 was found. This accounts for 56.8% of the variability in the skein values. While this correlation is not very high, relatively, it is necessary to keep in mind that strength of fibre is only one of the factors which determines yarn strength, and that other factors such as length of fibre, fineness, uniformity, and perhaps also maturity, play an important part. When a multiple correlation analysis was made using the same X-ray data and fibre length, fineness and maturity, a correlation coefficient of 0.91 was reached. This figure indicates that of all variability of the skein strength of 60s yarn, 82.5% was accounted for in this case by these fibre properties. And of this amount 69% was predictable from the X-ray measurements alone.

Indirect Measurement.—One objection that may be offered to the X-ray method is that it is indirect and that it can only be calibrated with the aid of other more or less imperfect methods. It may yet prove to be advantageous, in order to obtain the most efficient use of this new technique, to calibrate the X-ray pattern directly in terms of yarn strength. However, manufacturing organizations differ considerably, and since these differences affect yarn strength, it is thought that for purposes of evaluation greater progress can be obtained by use of the Chandler strength values which do not include these other factors not related to raw cotton strength.

Does Not Measure Spinning Value as Such.—From what has just been said and from the foregoing discussion it should be understood that the X-ray technique does not measure spinning value, as such, as the latter is generally understood. Spinning value is frequently thought of as being the potential relative value of a cotton compared on the basis of some property of a manufactured product. Strength of yarn is frequently used as a measure of spinning value although other measures, for example, elasticity or smoothness, are also possible. If we consider the strength of a yarn manufactured from cotton, we will realize that there are a number of factors not related to the strength of the raw cotton fibres. Among these may be mentioned length of fibre, fibre fineness, yarn twist, and perhaps combing, by increase of average length due to removal of short fibres, and by its straightening effect. For these reasons it is necessary to evaluate each factor separately and no single property of the fibre can hope to furnish, by itself, a measure of the spinning value.

Other Limitations.—In addition to the limitations mentioned above, several others probably should be mentioned although the extent of their influence has not yet been measured. One is due to the diffraction of long-chain fatty and waxy substances and possibly other similar substances which give a diffraction ring almost superimposed on the 002 cellulose ring which has been found to be most useful in strength determinations from the X-ray patterns of cotton fibres. This so-called fat and wax ring has been studied by Sisson [14] and is especially annoying in the case of very young fibres from unopened bolls when these are to be X-rayed. However, such interference seems to be practically absent from mature fibre patterns and it is not certain that any discrepancy results under ordinary circumstances. The effects, if any, of these substances on the X-ray measurements are being studied further.

A second and possibly more serious interference may be introduced by the activities of fungi and other micro-organisms. These not only penetrate the fibres but also secrete enzymes which dissolve the cellulose with great loss of strength to the fibre. It is possible that the arrangement of undamaged crystallites would continue to indicate a high strength, even though at intermediate points along the fibre the cellulose has been dissolved or destroyed. A special study is under way to determine whether this type of deterioration can be recognized by the X-ray measurements, and if not, what auxiliary tests will be necessary in evaluating commercial samples of cotton.

In a somewhat similar way the action of oxidizing agents as in bleaching, and of acids as in certain finishing operations, may reduce the strength of the fibre without causing a corresponding alteration in the diffraction pattern. It is planned to investigate these possibilities, too, in due time.

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Fundamental Properties of Textile Wastes. VII. Electric Charge on Escaping Gas Bubbles

By PHILIP H. BURDETT *

A Textile Foundation Publication

Experimental

SEVERAL investigators have reported that they have been successful in measuring the electric charge on a body of gas which has passed, in the form of small bubbles, through an aqueous solution. Their work was reviewed in the third paper of this series.[3] Among these workers were Townsend;[11] Fischer;[8] Busse;[4] Kelvin, MacLean and Galt;[9] Bloch;[2] and Coehn and Mozer[5] whose work seemed to be most successful. In the light of these reports we felt it to be incumbent upon us to determine the magnitude and practical control of the charge as suggested in the third paper of this series.[3]

The first apparatus tried consisted of a brass cylinder, gold-plated on the inside and heavily insulated with ceresin wax. A glass bubbler of known dimensions could be inserted through the side. The gas, after leaving the liquid, was passed upward through a glass funnel to reduce spattering and onto an aluminum plate connected with an aluminum leaf electroscope. It was found that no measurable discharge occurred unless the gas flow was increased to the point where noticeable spattering occurred. A glass cylinder of approximately the same size as the brass cylinder was substituted, but with the same result. The solutions used in both cases were distilled water and one molar sodium chloride solution. It was thus evident that, if there be a charge on the gas passed through these solutions, it is too small to be measured with the electroscope which we were using.

The absolute values of potential reported in the literature varied widely, but the most reliable work seemed to be that of Coehn and Mozer and they used a Dolezalek Electrometer to detect the charge. As a close approach to their bubbling chamber, we used a 125 cc. wash bottle from which the gas passed onto a thimble of platinum gauze which was connected with one set of quadrants of such an electrometer. There seemed to be an appreciable charge on the gas in this experiment and the charge reversed when salt solution was substituted for distilled water.

We built an FP–54 type vacuum tube electrometer using a Westinghouse RH–507 tube and used this electrometer in place of the quadrant instrument in all subsequent experiments. This electrometer was used with an Ayrton shunt and a mirror type galvanometer with an internal resistance of 775 ohms. The tube and working parts were carefully shielded as were

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the leads to the grid. With these precautions, the electrometer had a voltage sensitivity of about 2×10^{-6} volts/mm.

Again we used the wash bottle since it was a close approach to the chamber used by Coehn and Mozer. The assembly is shown in the accompanying figure. A is a wash bottle containing sulfuric acid, B is a pressure regulator with a leveling bulb, C is a manometer, D is an interchangeable capillary, E is a tube of glass wool, F is a grounded brass tube filled with brass shavings, G is a paraffin block for insulation, H is the bubbler, I is the platinum thimble.

There was an apparent charge on the gas coming from the bubbler which reached a maximum after about a minute and then fell off. This charge, in the case of one molar sodium chloride solution, was positive and was of the order of 1.5×10^{-4} volts. It was soon noticed that, when the grid was brought back to its floating potential and the experiment was repeated, the maximum scale reading was much lower than that originally reached and that, when the experiment was repeated several times, the maximum readings became successively lower. When the solution was replaced by a fresh solution, or by one through which air had not been passed for a day or more, this same

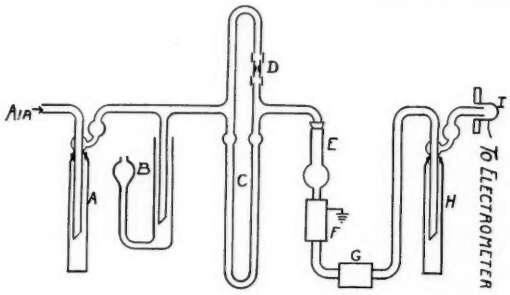

FIG. 1

series was repeated, the charge obtained from corresponding runs remaining approximately the same. We found it difficult to explain this result. In attempting to find an explanation, several other set-ups were employed. Finally, it was discovered that if the solution, after use, were heated to its boiling point and cooled, it regained its original state, and the charge obtained when this solution was returned to the bubbler had approximately the original magnitude. We concluded, therefore, that the air dissolved during the bubbling process affected the charge.

Among the different bubblers tried was a glass cylinder in the side of which was inserted a bubbler with an orifice of exactly 1 mm. diameter. The gas passed from the cylinder through the glass funnel previously used with the gold-plated chamber into a double-thickness thimble of platinum gauze, which was, as usual, connected with the grid of the electrometer tube. This cylinder was about 40 cm. high and, with the funnel, made a path of about 40–50 cm. for the air to rise after leaving the liquid surface. No charge was found on the gas in this case.

It was difficult to explain this in view of the results already obtained. The gold-plated cylinder again was tried with a bubbler of exactly 1 mm.

diameter orifice. No charge was found until the gas flow had been increased to the point where noticeable spattering occurred. This suggested the possibility that the charge which we had been measuring was on the water droplets and not on the gas. To check this the wash bottle was returned to the apparatus and the air was allowed to pass through slowly. The gas issuing from the bubbler was tested frequently with cobalt chloride paper as the gas flow was increased. It was found that there was no measurable charge on the gas until the dry cobalt chloride paper showed a color change indicating that an appreciable amount of moisture was passing over. This seemed to verify the supposition that it was the water and not the gas which carried the charge.

It still remained to find whether the gas has a charge under any conditions. The most favorable condition for the formation of a charge would be the exposure of a large surface of contact or, in other words, the breaking up of the gas into many very small bubbles. A glass cylinder was prepared having a cross-section of 35 mm. drawn down to 25 mm. at the bottom to receive a sintered glass plate which was to act as a bubbler. At the bottom there was an air inlet and a drain closed with a glass stop cock. Near the top was an exit tube with two bulbs to help prevent spattering. Distilled water, hundredth molar, tenth molar, and one molar sodium chloride solutions and glycerine were the solutions used, but in no case was there any measurable charge on the gas.

In line with the experience of Faraday [7] that the material from which the tip was made affected the charge, a set of metal tips was tried in connection with the gold-plated cylinder. Among these were a hypodermic needle with an opening about 0.1 mm. in diameter, another about ten times as large, and a brass tube with an inside diameter of about 5 mm. There was no charge on the gas with any of these.

A glass jar, fitted with a stop cock and a platinum gauze electrode, was evacuated causing distilled water to rise from the evaporating dish over which the jar was suspended. When most of the air was gone, the stop cock was closed and air was bubbled from a sintered glass bubbler. The gas which collected over the liquid was still uncharged. The metal tips mentioned above were substituted for the sintered glass bubbler, but with no effect.

Since it is known that polished steel is wet more readily by air than by water, a polished steel plate was substituted for the platinum thimble in several of the above set-ups, but there was no measurable charging of the gas.

The steel plate was immersed in the liquid and a stream of bubbles was impinged on it. The plate registered no charge even when the gas was shot at pressures of about 5 lbs. to the square inch.

In each of the above cases where the gold-plated cylinder was used, attempts were made to measure the charge on the liquid through which the gas was passing by connecting the cylinder with the electrometer. In each case this was unsuccessful.

Discussion of Results

In view of these results, it seems doubtful if there is actually any charge on the gas *after* passage through a liquid. The results obtained by various experimenters have failed to check, not only in regard to the magnitude of the charge on the gas, but in regard to the sign of the charge. It seems probable that they have been measuring the charge on water entrained by the gas. In considering the work of Coehn and Mozer, it might be pointed out that the gas passing through their bubbler traveled a rather short path,

free of baffles, before reaching the electrical filter. In view of our experience it seems highly probable that the gas in their apparatus did entrain some liquid.

Our conclusion seems reasonable when consideration is taken of the possible mechanism by which the gas could carry the charge. Whatever the assumed mechanism by which the gas bubble obtains a charge by passage through a liquid, it must be assumed that, after leaving the liquid, the gas must carry a material particle. In the case of negatively charged gas this need be only the comparatively small electron, but if the gas ever has a positive charge it is hard to see how this charge could be due to anything other than an adsorbed positive ion. That a gas is able to carry a large number of such particles far above the surface of an oppositely charged liquid is hard to believe.

It should be pointed out that this does not preclude the possibility of the bubble being charged while it is in the liquid. There is much evidence that it *is* charged while in the liquid. The cataphoresis experiments of MacTaggart,[10] Alty,[1] and Currie [6] support this, as does the common case of coagulation of bubbles passing through a sol near its iso-electric point.

Conclusions

In view of the results obtained in this investigation, we believe it is improbable that a body of gas after it has passed through a liquid in the form of small bubbles carries an electric charge. If the gas does carry a charge it is impossible to measure it under the experimental conditions described.

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Fundamental Properties of Textile Wastes. VIII. The Flotation of Colloidal Suspensions†

By J. E. MAGOFFIN and B. R. CLANTON *

A Textile Foundation Publication

Summary

Substances in colloidal suspension can be floated successfully, the floatability being dependent on the electrokinetic properties of the substances involved. Floating agents must be charged oppositely to the particles to be floated, and must be capable of producing a water repellent coating on these particles.

Introduction

CONCENTRATION of ores by flotation methods has long been used in the mining industry when economical and simple methods of separating two or more solid phases are required. If the surface of one solid phase is made water repellent by the addition of a suitable agent, the bubbles of air rising through the mixture attach themselves to this surface and the particles are carried into the froth and removed. The substances that do not acquire water repelling coatings remain in the body of the mixture. This is the fundamenttal theory of flotation.

The ability to produce a froth is not of itself enough to qualify a material as a good floating agent. The substance must adhere strongly to the particles and it must form a coating around the particles which is more readily wet by air than by water. Thus, to make successful the flotation of any substance dispersed in water, it is only necessary to use the appropriate floating agent. With this in mind this investigation was begun in the hope of finding flotation a feasible method of clarifying textile mill wastes.

In the majority of cases, the substances found in textile mill wastes are present in colloidal suspension, and the particles are charged electrically, the charge being responsible for the stability of the systems. Since the floating agent must adhere strongly to the particles to be floated, those which have a charge opposite to that of the particles will be the most successful. Keeping in mind that they must also be capable of producing a

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* Dr. Magoffin is a Senior Investigator, and Mr. Clanton a Junior Investigator, of the Textile Foundation, working under the direction of Dr. Frank K. Cameron at the University of North Carolina.

water repellent coating, we can select our floating agents with little difficulty. For positive suspensions, soaps, "Gardinols," and salts such as sodium benzoate should be suitable; for negative ones, aromatic and fairly long-chain aliphatic amines. The charge carried by these agents will insure adsorption by the particles to be floated, and the oily "tails" of each will impart water repelling properties to the coating.

Bull, Ellefson, and Taylor [1] have shown that the floatability of galena and some other mineral suspensions in water varies directly as the potential on the particles. Variation of potential with experimental conditions will, in all probability, be the determining factor in any change in the character of flotation with a given agent. For this reason migration velocity studies were carried out on all of the suspensions investigated.

Apparatus and Experimental Technique

The apparatus and experimental technique for flotation and migration velocity experiments have been described in previous papers.[2, 3]

In the flotations of negative suspensions in which the amine and acid were added separately, the amine was always added first and the acid immediately after. The portions were so chosen that small change in pH of the flotation mixture resulted.

Preparation of Suspensions

The ferric oxide sols were prepared as suggested by Sorum.[4] Eighty cc. of one molar ferric chloride solution were dropped at the rate of two drops per second into one liter of boiling water. When the hydrolysis was complete, the sol was allowed to cool and then stored in a pyrex flask, to be used as stock solution. Aluminum oxide and chromic oxide sols were prepared by precipitation of the oxides from solutions of the chlorides and washing free from excess electrolytes. The washing was facilitated by using a centrifuge, and was continued until the oxide particles remained in suspension when subjected to 1,300 times the force of gravity. The resulting suspensions were stored in pyrex flasks after careful analysis. Basic Brown (Color Index No. 331) suspensions were made in the same way, precipitating the dye with sodium hydroxide from a solution of the chloride.

A stock suspension of indigo (Color Index No. 1177) was made by adding water to a 20% paste of pure dye and running through a colloid mill for ten minutes. Congo Red was precipitated from solution with hydrochloric acid and washed free from excess electrolytes in the centrifuge. A sulfur black (Color Index No. 978), made from 2, 4 dinitro-phenol, was dissolved in a 40% sodium sulfide solution, using two grams of dye to 200 cc. Two grams of medical adsorbent cotton were ground in a porcelain ball mill with 500 cc. of distilled water for eight hours. The larger particles and inorganic impurities were removed by centrifuging, and the resulting suspension used as a stock solution.

With the exception of the ferric oxide, all the suspensions were diluted to 0.1 gm. per liter for both the flotation and migration velocity experiments. The pH was regulated by addition of hydrochloric acid or sodium hydroxide before final dilution. The ferric oxide sols were diluted to 0.22 gm. per liter.

For floating agents we used Baker's U. S. P. Neutral Powder sodium oleate, C. P. sodium benzoate, and "Gardinol" WA (the sodium sulfate of lauryl alcohol) for the positive suspensions. With the negative suspensions we used Baker's C. P. aniline, C. P. pyridine, naphthylamine, Triton K60, and "Hyamine" (a tertiary amine). The last two are products of the Röhm and Hass Co.

Experimental Results

The results of the migration velocity experiments are plotted in Figs. 1 and 2, and the general picture of the flotation experiments is given in Tables 1 and 2. There are, however, some additional experiments, the

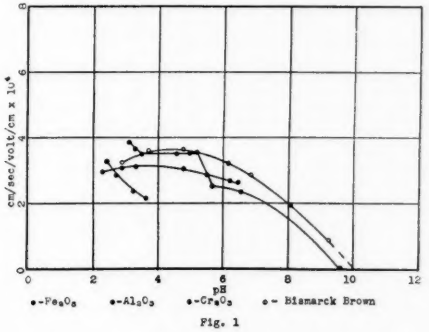

Fig. 1

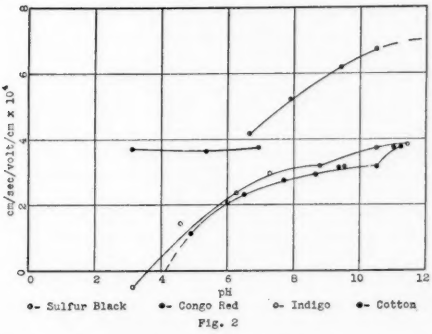

Fig. 2

results of which are not included in the tables. Several of the reagents tried with negative suspensions were so unsatisfactory that tabulation of the results is impractical. Flotations with pyradine were unsuccessful with everything but indigo, while only sulfur black was floated by Triton K60. The sample of "Hyamine" was received too late to make more than preliminary experiments, but these were successful with all the negative suspensions except cotton.

TABLE 1

Suspension	pH	u x 10^4 in cm/sec/ volt/cm	Reagent and volume used for complete flotation. Na Oleate	Gardinol	Na Benzoate
			5% sol.	5% sol.	5% sol.
Fe_2O_3, 0.22 gm. per lit.	2.40	3.29	30.2	11.0	21.0
	2.70	2.89	7.0	1.4	8.9
	3.61	2.16	2.5	0.6	2.0
			1% sol.	1% sol.	1% sol.
Al_2O_3, 0.1 gm. per lit.	3.08	3.87	13.0	2.4	7.5
	3.50	3.51	10.3	2.3	13.0
	5.18	3.55	7.0	6.0	
	6.53	2.39	4.2	3.6	
			1% sol.	1% sol.	1% sol.
Cr_2O_3, 0.1 gm. per lit.	2.29	2.93	10.0	1.9	
	3.31	3.11	10.3	1.0	
	4.80	3.06	5.0	1.2	
	6.40	2.58	1.5	0.4	
			1% sol.	1% sol.	1% sol.
Basic Brown, 0.1 gm. per lit.	3.28	3.41	13.5	6.0	21.0
	4.72	3.58	3.0	3.5	
	6.15	3.21	3.0	5.3	
	8.05	1.93	4.0	5.3	

NOTE: Where incomplete or no flotation was obtained the amount of reagent used is not recorded.

Discussion of Results

Although it is not the purpose of this paper to discuss in detail the migration velocity experiments, a brief interpretation of the curves is in order. The migration velocity has been plotted rather than the zeta potential, because truly accurate calculation of the latter is not possible, and even its very existence is doubtful. The migration velocity itself is an accurate index of the electrokinetic properties of the particles. The smooth portions of the curves indicate that only one solid phase is present in the surface of the particles. This may best be described as a continuous series of adsorption complexes. The sudden breaks in the curves indicate the appearance of a second solid phase in the surface. The significance of the curves with respect to flotation will be discussed in detail for each suspension investigated.

1. *Ferric Oxide.* Over the range studied there is no break in the migration velocity curve, so we may assume that but one solid phase is involved in flotation, since only the surface of the particles comes in contact with the floating agent. As the migration velocity falls off rapidly with increase in pH, the attraction for the floating agent is decreased. Since the charge on the agents increases with pH, the quantity required for complete neutralization of the ferric oxide is decreased tremendously. As long as the particles are still coated enough to be water repellent, the change is for greater efficiency. The flotation with sodium oleate is peculiar in that

TABLE 2

Suspension	pH	u x 10^4 in cm/sec/volt/cm	Reagent and volume used for complete flotation. Aniline + HCl		Naphthylamine in alc. + HCl	
			C.P.	1 N	3.2% sol.	0.1 N
Congo Red, 0.1 gm. per lit.	5.35	3.64	1.0	1.0	1.0	2.0
Cotton, 0.1 gm. per lit.	4.55	0.70	1.5	15.7	2.0	4.4
	6.55	2.31	2.0	20.0	1.7	2.6
	7.93	2.88	4.0	42.0	2.0	4.4
	9.64	3.17	3.5	35.0	2.0	3.2
	10.40	3.19	3.0	30.0	2.0	4.4
	10.85	3.55	No Flotation			
Sulfur Black, 0.1 gm. per lit.	7.78	5.10	0.6	1.2	1.2	1.1
	8.69	5.75	0.8	1.2	1.8	0.3
	10.40	6.70	1.0	1.8	2.4	1.0
			Aniline HCl 5% sol.		Naphthylamine HCl 2% sol.	
Indigo, 0.1 gm. per lit.	4.35	0.78	9.1		20.0	
	5.20	1.58	8.8		25.0	
	7.00	2.85	25.4		34.0	
	10.90	3.77	32.0		52.0	

NOTE: The addition of 0.1 cc. of aniline to the indigo flotations cuts down the time required for complete removal.

the air bubbles in the froth are so small as to be almost invisible. The froth has the consistency of a heavy oil and is very stable, remaining fluid for as long as six months. The "Gardinol" froth is not unusual, but the benzoate froth is rather heavy and will stand for several days.

2. *Aluminum Oxide.* The three sharp breaks in the velocity curve indicate that at least three, probably four different solid phases are present in the surfaces of the particles, each one stable over a different range of pH. Sodium oleate is capable of floating all four, the amount of oleate required for complete flotation falling off with decrease in migration velocity. "Gardinol" floats all four, but not with equal ease, while sodium benzoate floats only the first two. The "Gardinol" flotations of the two at the higher pH's require an unusually long time, and are characterized by extensive frothing. Considerable amounts of the reagent are removed from the field of action by this frothing, and thus the larger amounts required for complete flotation are accounted for. The alumina is precipitated by the benzoate in the two higher pH ranges, which indicates that, although the benzoate is adsorbed by the alumina, not enough adsorption takes place to form a water repellent coating on the particles.

3. *Chromic Oxide.* There is a maximum in the velocity curve, but since the curve is smooth there is probably only one solid phase in the surface of the particles. The flotations with oleate and "Gardinol" are very satisfactory, the amount of reagent varying with the migration velocity. Sodium benzoate precipitates Cr_2O_3, but under no conditions is the flotation

successful. The benzoate film is not extensive enough to make the entire particle surface water repelling.

4. *Basic Brown.* The maximum in the velocity curve is more pronounced than that in the case of chromic oxide, but in all probability the surface of the particles consist of only one solid phase. The falling off at the extreme acid end of the curve may be attributable to the fact that considerable amounts of the dye are in true solution at these pH's. It is possible to float all of the colloidal dye in these suspensions, but not that in true solution. Flotation with benzoate is complete only at the very low pH, probably not enough being adsorbed at the higher pH's to completely cover the particles. The dye is precipitated at the higher pH's by the benzoate.

5. *Congo Red.* As indicated by the migration velocity curve, the charge on the particles is practically unaffected by changes in pH over the range studied. Addition of acid to the suspension causes precipitation of part of the dye, leaving the remainder in suspension, with practically the same migration velocity. Addition of base takes some of the dye into true solution, the remainder, again, retaining the original velocity. For these reasons complete flotation can be accomplished only over a very narrow range of pH. The addition of the amine and acid must be in such proportions that the pH is maintained very close to 5.35.

6. *Cotton.* The surface of the cotton particles consists of one solid phase below a pH of 10.50 and of a different one above that pH. Flotation is successful only below 10.50, and the amount of reagent required for complete flotation is proportional to the migration velocity. For lack of time, flotation with "Hyamine" was tried at only one pH, and further experiments are needed before an explanation of its failure can be attempted.

7. *Sulfur Black.* Since sulfur black appears to be in true solution, the significance of the migration velocity curve is different from that for the other curves. The fact that the velocity is affected by small additions of hydrochloric acid indicates that the sulfur black ions, if they may be called such, are quite different from ordinary inorganic or small organic ions. Although no Tyndall effect is to be observed, we think it is safe to assume that the size of the sulfur black ions approaches that of colloidal particles. The ion is probably a complex one, resulting from reaction with sulfide ions in solution.

Flotation was good with all of the reagents tried, but in some cases it was not 100%. In no instance did the removal fall below 90%, and since the dye is in true solution the results are very gratifying.

The success of flotation of sulfur black with Triton K60 is in contrast with the failure of this reagent with the other negative suspensions. Measurements of the migration velocity of Triton K60 showed it to be well above those of Congo Red, indigo and cotton, but below that of sulfur black. Thus the first three substances cannot adsorb enough Triton K60 to acquire a water-repellent coating, while sulfur black, because of its higher charge, does absorb enough.

8. *Indigo.* The break in the migration velocity curve indicates that the surface of the particles contains two different solid phases. One is stable below a pH of 8.80 and one stable above. Both types of particles can be floated with all of the agents tried, except Triton K60. The amount of floating agent required varies with the velocity of the Indigo. Although flotations are successful with pyridine, the high solubility of pyridine leads

one to conclude that the water repellent surface is due to the Indigo rather than the pyridine. The failure of pyridine to work with the other suspensions supports this conclusion.

Conclusions

1. Cataphoretic studies have been made on seven colloidal suspensions, and the effect of pH on the migration velocities has been determined.
2. The effect of pH on the migration velocity of sulfur black, a dye in true solution, has been determined.
3. Both positive and negative suspensions, and one true solution have been floated successfully.
4. The requirements of good floating agents for colloidal suspensions have been determined; the agent must be charged oppositely to the particles to be floated, and must be capable of forming a water repellent film or coating around the particles.
5. The larger the charge of the floating agent as compared to the charge carried by the particles to be floated, the more efficient the flotation, within reasonable limits.

References

1. Bull. Ellefson, & Taylor. *J. Phys. Chem., 38,* 401 (1934).
2. B. R. Clanton. *Tex. Rsch., 8,* 270–75, 301–4 (1938).
3. Magoffin and Hatch. *Tex. Rsch., 8,* 305–9 (1938).
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(*Continued from page 340.*)

in the South of a $100,000,000 group of pulp and paper mills. The economic rehabilitation of his native Southland was Dr. Herty's life-long dream, and it is doubtful if any other man has contributed so much to that objective.

He was born in Milledgeville, Ga., in 1867, was educated at the Georgia Military and Agricultural College, the University of Georgia and Johns Hopkins University. An outline of his career and of his many contributions to the chemical, paper and textile industries was published in the March, 1938, issue of this journal. He was a valued advisor of U. S. Institute for Textile Research in its early years, and had it not been for the financial aid given to his slash-pine pulp research in 1931 by Francis P. Garvan, our former president, it is possible that Dr. Herty and not Mr. Garvan might have been the successor of Dr. Stratton. Few research chemists have had the good fortune during their lifetimes to erect such an enduring monument to their fame as has Dr. Herty. He is survived by two sons, Charles Holmes and Frank Bernard, and by a daughter, Sophie Dorothea Herty.

Abstracts

Committee on Abstracts and Bibliography:
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Address, C. H. Clark, Sec., 65 Franklin St., Boston, Mass.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Absorption of Tannic Acid by Viscose Rayon. VI. K. Hishiyama and M. Sekido. *J. Soc. Chem. Ind., Japan* 40, 1937, Suppl. binding P. 346–7; cf. *C. A.*, V. 28, Col. 5248; abs. in *C. A.*, 1938, V. 32, Col. 1464.

In continuing this series of expts. H and S now detd. the relation between the concn. of the mordanting bath and the amt. of tannic acid absorbed at various temps. Skeins of viscose rayon were steeped to equil. in 20 vols. of tannic acid solns. varying in concn. from 1 to 10% on the wt. of the rayon. The lower the temp. of the bath the more tannic acid is absorbed. The absorption follows Freundlich's adsorption isothermal formula. (W)

Casein Wool. Otto Pennenkamp. *Spinner u. Weber*, 1937, V. 55, No. 44, P. 24–6; abs. in *C. A.*, 1938, V. 32, Col. 1462.

The method of manuf. is described. The phys. properties are compared to those of sheep wool. (W)

Casein: Preparation of Wool-like Staple Rayon from. A. S. Shpital'nyi, A. I. Valeshkevich and R. S. Lyasheh. *J. Applied Chem.* (U. S. S. R.), 1937, V. 10, P. 1053–63; abs. in *C. A.*, 1938, V. 32, Col 1462. (W)

COTTON FIBRE: SPINNING QUALITY. F. T. Peirce. *Empire Cotton Growing Rev.*, 1937, V. 14, P. 286–93; abs. in *J. T. I.*, Feb. 1938, P. A98.

Under the title "What kind of cotton *do* they want?" the author discusses the qualities of cotton and the means of testing them in the field and laboratory. The hair-weight, corrected to a standard maturity ratio, gives a Standard Hair-weight which may be converted into the equivalent "count" of 100 hairs, a quantity called the "Intrinsic Fineness." This appears to be the most stable genetic character of lint and more closely correlated with spinning quality than any other factor. (C)

COTTON YARN CHARACTER: SOME FACTORS AFFECTING. C. B. *Tex. Mfr.*, March 1938, P. 95.

Fundamental to all yarn character is the character of the raw cotton. The longest, finest and most uniform cotton will make the most smooth and lustrous yarn, permitting the use of the highest as well as the lowest twist multiplier. If a full and springy yarn is required, a thicker cotton of high hair weight per centimeter and harsh handle is likely to suit requirements, while if a soft oozy yarn is required a soft and irregular cotton will contribute to this end. (C)

FABRICATION OF ARTIFICIAL WOOL. G. Genin. *Lait*, 1937, V. 17, P. 949–55; abs. in *C. A.*, 1938, V. 32, Col. 786.

A general discussion is given of the manuf. of casein and the fabrication of artificial wool fibres (Lanital) therefrom. (W)

II. YARNS AND FABRICS

CREASE-RESISTANT FINISHES FOR FABRICS: EVALUATION OF. Herbert F. Schiefer. *B. S. J. Rsch.*, Feb. 1938, P. 241–52.

Certain flexural characteristics of representative woven fabrics before and after the application of commercial crease-resistant finishes were measured using three different methods, namely, the creasing angle, flexometer, and modified compressometer methods. Specimens of paper, Cellophane, cotton, rayon, worsted, and rubber, which are recognized to vary in resistance to creasing over a great range, were also measured by the three methods and the results used for comparison.

The crease-resistant finishing treatments increased the energy required to deform the cloth specimens, that is, increased the stiffness of the cloths. This increase exceeded 100% for some of the cloths. The energy of recovery was also increased by these treatments, the increase ranging from 20 to 100%. Neither of these two quantities can be taken individually as a measure of crease resistance. However, the ratio of the latter to the former, here termed "resilience," is related to the resistance to creasing. The resilience of nearly all of the cloths, as determined by each of the three test methods, was increased by the crease-resistant finishing treatments.

The three test methods described can be used to evaluate the improvement given by crease-resistant finishes, using the measurements on the cloths before treatment as the basis of comparison. The methods should be valuable in systematic studies of the effect of different finishing treatments and in determining the effects of relative humidity, temperature, and other

factors on the different finishes. Although the test methods described in this paper indicate whether or not an improvement in crease resistance results from a finishing treatment, they may not clearly indicate the relative merits of the fabrics of different compositions and constructions from the viewpoint of the user. For this there appears to be needed, first, a standard procedure for subjecting fabrics to creasing forces in a manner and under conditions that can be correlated with normal use of the fabrics, and, second, a method for evaluating the changes in appearance the fabrics undergo in this treatment. Work on the development of an optical method of test for this purpose is being undertaken in the Textile Section of the National Bureau of Standards. (W)

DOUBLE-WOVEN WARP PILE FABRICS. Part I. W. Watson. *Tex. Mfr.*, April 1938, P. 149, 154.

Methods of weaving double-pile fabrics, weaves, yarns, and particulars. (C)

DRYING OF FABRICS WITH PARTICULAR CONSIDERATION OF THE DRYING DEVICE. Hans Leppin. *Spinner u. Weber*, V. 55, No. 44, P. 23; *Deut. Textilwirt.*, V. 4, No. 20, P. 9; *Klepzig's Textil-Z.*, V. 40, No. 38, P. 3 (1937); abs. in *C. A.*, 1938, V. 32, Col. 1465. (W)

DRYING OF TEXTILES WITH AIR: PROBLEMS OF. Adolph Rossie. *Monatsh. Seide Kunstseide*, 1937, V. 42, P. 423–7; abs. in *C. A.*, 1938, V. 32, Col. 1465.

A detailed discussion dealing with the temp. of the textile to be dried, the drying process in the hygroscopic region, velocity of drying and related problems, control and regulation of the drying process and elongation and shrinking processes during drying. (W)

FULLING OF FABRICS WITH FAT. H. Berg. *Monatschr. Textil-Ind.*, 1937, V. 52, P. 293; abs. in *C. A.*, 1938, V. 32, Col. 1104.

The fat-fulling method is less expensive and less time consuming than fulling with soap, but cannot be used equally well for all fabrics. Only such fats should be used which later on can be sapond. easily and completely with 2–3° soda without the addn. of other chemicals. If, however, this soda soln. does not produce complete soln., a suitable chem. fat solvent rather than a more concd. soda soln. should be used. Fat fulling should not be employed on fabrics requiring a long fulling period. It should also be avoided for fabrics in which the warp has been sized with flour or starch products. In fat fulling, either too little or too much moisture gives unsatisfactory results, particularly if the goods contain large amts. of staple rayon. (W)

HEAT TREATMENT OF TEXTILE FABRICS. Spooner Dryer and Engineering Co. Ltd. *Tex. Mfr.*, March 1938, P. 109.

New processes of finishing of textile materials and the use of fabrics as reinforcement in certain articles have called for adaptation of drying machines to high temperature work under strictly controlled conditions for the fabrics, temperature and time of treatment. (C)

JUTE MANUFACTURE: PROGRESS AND PROSPECTS OF. *Tex. Mfr.*, April 1938, P. 147.

New knowledge has established the "individuality" of jute, and its special problems, methods of manipulation, etc., are being investigated by the Research Organization of the Indian Jute Mills' Association. The new developments and possibilities are reviewed. (C)

"LANITAL": IN DEFENSE OF. Hector C. Borghetty. *Am. Dye. Rptr.*, Mar. 21, 1938, P. 156–8.

Describes the physical and chemical properties of Lanital, its identification, and its dyeing and finishing. Suggests its classification as a rayon having a chemical constitution similar to that of animal fibres, but greatly resembling the various rayons physically. (C)

LATEX AND STARCH PRODUCTS IN TEXTILE FINISHES: USE OF MIXTURES OF. V. Hinzelin. *Tiba*, 1937, V. 15, P. 563–7; abs. in *C. A.*, 1938, V. 32, Col. 1467.

Tests carried out on a com. scale and with industrial equipment, using latex in conjunction with starch, sol. starch and dextrin, and vulcanized latex in conjunction with sol. starch, are described. (W)

MERCERIZED COTTON FABRICS: REACTIVITY TOWARD IODINE. A. J. Hall. *Tex. Wkly.*, 1937, V. 20, P. 463, 465, 467, 605, 607, 609; abs. in *C. A.*, 1938, V. 32, Col. 1464.

A review. Cf. Garkusha (*C. A.*, V. 31, Col. 7659); Schwertassek (*C. A.*, V. 28, Col. 6571). (W)

METHYLCELLULOSES AS MODERN WARP SIZING AGENTS. R. Brauckmeyer. *Deut. Wollen-Gewerbe*, 1937, V. 69, P. 1455–7; abs. in *C. A.*, 1938, V. 32, Col. 1105.

Water-sol. methylcelluloses, particularly Tylose TWA 25 and TWA 100, can be used effectively for the sizing of worsted and carded yarns of various yarn strengths and thicknesses and consisting of pure wool, mixed textiles, staple rayon, rayon or cotton. The sizing effect is particularly good in 1.5% soln. Comparative tests on the increase in strength caused by sizing with methylcelluloses and with potato starches showed better results with the former. The Tylose-sized yarns exhibit better elasticity. Another advantage is the stability of the methylcellulose solns. The Tylose-treated goods are not subject to bacterial attack. Methylcellulose does not endanger the action of the washing and fulling agents (decompg. starch soln. hampers tanning operations) but has just the opposite effect. Thus colloidal Tylose soln. aids in the washing with dil. soap solns. and suppresses the formation of a Ca soap pptns. during the rinsing of fulled or washed fabrics. (W)

PERMANENT SIZES: REALIZATION OF. Louis Bonnet. *Teintex*, 1937, V. 2, P. 679–87; abs. in *C. A.*, 1938, V. 32, Col. 1105.

A complete review of the literature and patents relating to permanent sizes and fillers. (W)

MILLING OF WOOL-STAPLE FIBRE FABRICS. R. Gutensohn. *Klepzig's Textil-Z.*, 1937, V. 40, P. 691–2, 701–2; abs. in *J. T. I.*, Feb. 1938, P. A83.

Proprietary products are recommended for the milling, oiling and sizing of wool-staple fibre fabrics. For heavy milling, a 25–30% admixture of staple fibre should not be exceeded. For making felt, tests show that with 80% staple fibre and 20% wool the most satisfactory staple fibre is Vistra XT. For ordinary milling, the most satisfactory are Vistra XT and Lanusa, which both possess a wool-like surface and structure. It is stressed that the wool and the staple fibre must both be of the same fineness and length. (C)

SANFORIZING: INCREASE OF THE VALUE OF TEXTILE FABRICS BY. Horst Friedemann. *Klepzig's Textil-Z.*, 1937, V. 40, P. 619–21; abs. in *C. A.*, 1938, V. 32, Col. 1467. (W)

SCOURING AND BLEACHING MACHINE: CONTINUOUS. Erekens and Brix K. G. (Rheydt). *Leipzig. Monatschr. Text. Ind.*, 1937, Fachheft III, P. 79–80; abs. in *J. T. I.*, Feb. 1938, P. A83.

An illustration and section diagram are given of a machine for the continuous scouring and bleaching of fabric in rope form in which feeding and mangling arrangements are devised to do the minimum of damage to materials such as rayon staple fibre. (C)

SIZING AND FINISHING AGENTS: MODERN. Hate. *Klepzig's Textil-Z.*, 1937, V. 40, P. 652–3; abs. in *C. A.*, 1938, V. 32, Col. 1465.

The sizes of the polyvinyl or protein types do not require any particular desizing of the fabric as the size is removed completely during washing. Properties and uses of some of the new products are described. (W)

SIZING OF RAYON AND STAPLE RAYON. I. THE EFFECT OF LINSEED-OIL SIZES UPON THE VALUE OF RAYON. II. THE SKEIN SIZING OF RAYON WITH WATER-SOLUBLE SIZES. W. Schramek and H. Scheufler. *Monatschr. Textil-Ind.*, 1937, V. 52, P. 81–4, 112–6, 137–40; abs. in *C. A.*, 1938, V. 32, Col. 1465. (W)

STABILITY OF THE RUSTLING OF FABRICS. Frische. *Deut. Wollen-Gewerbe*, 1937, V. 69, P. 1111; abs. in *C. A.*, 1938, V. 32, Col. 362.

A short discussion of various industrial processes of inducing and stabilizing rustling in mixed textile fabrics. (W)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

ACID DYES: THEORY OF DYEING WOOL WITH. IV. ACIDITY OF FREE DYE SULPHONIC ACIDS OF SOME ACID WOOL DYES. W. Ender and A. Müller. *Mell. Textilber.*, 1937, V. 18, P. 906–7; abs. in *J. Soc. Dyers Col.*, March 1938, P. 137. (C)

ACID WOOL DYESTUFFS MAY NOW BE APPLIED TO CELLULOSE AND RAYON. J. Wakelin. *Tex. Col.*, April 1938, P. 227–30. (C)

ANILINE BLACK. George A. Moran. *Am. Dye. Rptr.*, May 2, 1938, P. 231–6.

Describes a number of processes to produce aniline black, all having the purpose of reducing cost or eliminating tendering. "With formulae of the type mentioned," states the author, "a processor can secure satisfactory results with the proper apparatus under the guidance of trained operators. When well applied, aniline black will hold its own against all other blacks and we predict it will be many a year before we find this time-tested black eliminated in the 'pitching' of print patterns." (C)

ARIDYE PRINTING. Anon. *Tex. Wld.*, May 1938, P. 60–1.

The Aridye process of printing, which makes use of several new series of colors, has been subjected to practical mill trials and seems to have emerged from the experimental stage. This article describes the present status, and seeming possibilities and limitations of the process. The Aridye colors are described as consisting of "insoluble pigments of fine particle size uniformly dispersed in a vehicle in the form of a thin paste in which are incorporated carefully selected water-soluble binders. When the Aridyes are applied to a fabric and the solvent is driven off, there is an entanglement of color particles by the fibres. The fixing of the particles to the fibres is aided by the binders. The result is, apparently, a coating of the individual fibres with color particles." (C)

CELLULOSE ACETATE RAYON FIBRES: SOME PROPERTIES OF—OF INTEREST TO DYERS AND FINISHERS. H. DeW. Smith. *Am. Dye. Rptr.*, April 18, 1938, P. 213–7.

Paper presented at meeting, Piedmont Section, A. A. T. C. C., Nov. 6, 1937. (C)

COLOR MATCHING: TECHNIQUE OF. Carl E. Foss and Norman Macbeth. *Rayon Tex. Mo.*, 1938, April, P. 87–8; May, P. 70–1, 73. (C)

DYEING OF ANODIZED ALUMINIUM. V. F. Henley. *J. Soc. Dyers Col.*, March 1938, P. 100–4.

The dyeing of anodized aluminium being so closely connected with the production of anodic films, the author gives a brief survey of the development and technique of these processes in the belief that it will assist in an appreciation of the problems encountered in establishing the dyeing processes on a commercial basis. (C)

ETHYLENE DERIVATIVES AS SOFTENING AND FINISHING AGENTS FOR TEXTILES. "Technologist." Tex. Reedr., March 6, 1938, P. 41. (C)

FAST DYEINGS ON WOOL PARTICULARLY FOR UNIFORM CLOTHS. H. Brandenburger. *Tex. Col.*, April 1938, P. 240–2, 276. (C)

GLYCERINE SUBSTITUTES FOR TEXTILE PURPOSES. *Wool Rec.*, 1937, V. 52, P. 1378–81, 1394; abs. in *J. T. I.*, Feb. 1938, P. A76.

The properties and uses of ethylene glycol and dextro-sorbitol are described. For wool sizes, sorbitol-softened glues possess greater firmness

and permanence than glycerine-softened glues, the ideal mixture probably consisting of both sorbitol and glycerine. Mention is also made of sodium lactate. (C)

INDIGOSOLS IN THE PRINTING OF TEXTILE FABRICS: USE OF. R. Löser. *Klepzig's Textil-Z.*, 1937, V. 40, P. 624–6, 651–2; abs. in *C. A.*, 1938, V. 32, Col. 1458.

A detailed review of chem. and mech. methods utilizing these stable, water-sol. leuco esters of the vat dyes. The developed dyeings and prints have nearly the same fastness as the vat dyes themselves. (W)

INDIGOSOLS. W. Christ. *J. Soc. Dyers Col.*, March 1938, P. 94–100.

A survey of the dyeing technique of this group of dyes, followed by discussion. (C)

LACQUER PRINTING: TECHNIQUE OF. M. A. Dorian. *Rayon Tex. Mo.*, 1938, March, P. 57–8; April, P 83–4. (C)

MERCERIZATION OF STAPLE RAYON. Kurt Heide. *Kunstseide u. Zellwolle*, 1937, V. 19, P. 314–23; abs. in *C. A.*, 1938, V. 32, Col. 1466. (W)

OIL AND FAT EMULSIONS IN THE TEXTILE INDUSTRY. A. Foulon. *Allgem. Ole- u. Fett-Ztg.*, 1937, V. 34, P. 451–3; abs. in *C. A.*, 1938, V. 32, Col. 787.

The methods of using emulsions to impregnate textiles and paper with drying oils, fats, metallic soaps, waxes or mineral for waterproofing or other reasons are described. (W)

ORGANIC STABILIZERS OF HYDROGEN PEROXIDE FOR BLEACHING OPERATIONS. R. Folgner. *Monatschr. Textil-Ind.*, 1937, V. 52, P. 257–9; abs. in *C. A.*, 1938, V. 32, Col. 1460.

A discussion of the use of various patented stabilizers. (W)

PERSPIRATION ON DELUSTERED SILK HOSE: EFFECT OF. Anon. *Dyer*, 1937, V. 78, P. 435; *Silk and Rayon*, 1937, V. 11, P. 1148; abs. in *C. A.*, 1938, V. 32, Col. 1464.

An evolution of H_2S from delustered hose was traced to the presence of ZnS. Other hose tested showed the presence of soluble barium salts that might lead to poisoning. A formula for artificial perspiration is given. (W)

pH VALUE, ITS APPLICATION AND RAPID DETERMINATION. L. H. Fischer and I. Fischer. *Deut. Textilwirt*, 1937, V. 4, No. 22, P. 22–4; abs. in *C. A.*, 1938, V. 32, Col. 1104.

The pH values given are best for the treatments described. Washing with soap: Min. at 9, max. at 10.7; washing with Gardinol. Igepon and Igepal, 2–12; desizing, sizing and finishing, malt enzyme (Diastafor) 4.6–5.2. Pancreas enzyme (Degomma, Viveral), 616–6.8, bacterial enzyme (Biolase) 7; silk degumming and weighting, 10; heating of wool-contg. goods, 8–10 (most favorable at 9.1 and 80°); larding of wool and wool-contg. mixts., 10–11 (and even in acid soln. if highly efficient neutral special textile aids

are used); 0 bleach in the presence of water glass or Mg silicate, 618–8.4; hypochlorite bleach, 8. No general definite optimum pH value can be given for dyeing, steeping, developing, obtaining the silk feel, impregnating, prepn. of emulsions, comparative tests of textile aids, rinsing and drying. Baths used for finishing acetate rayon should not have a pH over 10, if possible. The turbid impurities in feed water are best pptd. at pH 5.5 ($Al(OH)_3$). Boiler feed water should have pH 10–12. $Mg(OH)_2$ and $CaCO_3$ are pptd. best at pH 10.5 and 9.4 resp. (W)

pH Control in Textile Dyeing and Finishing. A. R. Wallberg. *Canadian Tex. J.*, May 13, 1938, P. 35–7.

Paper delivered at meeting of Ontario Section, Canadian A. T. C. C., April 2, 1938. (C)

(How) Quaternary Compounds Help the Dyer. H. Peters. *Rayon Tex. Mo.*, March 1938, P. 55–6, 60.

The author points out the important place quaternary compounds occupy in the dyeing, after treating and stripping of cotton, rayon and other textile materials. (C)

Synthesis of Indigotin. F. Henesey. *J. Soc. Dyers Col.*, March 1938, P. 105–15. (C)

Synthetic Resins: Possibilities of—in Dyeing, Printing and Finishing. J. Wakelin. *Tex. Col.*, March 1938, P. 157–60. (C)

Wool-Staple Fibre Mixtures: Practical Hints on the Avoidance of Uneven Dyeing of. *Deut. Färber-Z.*, April 3, 1938, P. 175–6; reprinted in *Silk J. & Rayon Wld.*, April, 1938, P. 22. (C)

Wool: Unlevel Dyeing of—with Acid and Chrome Dyes. E. Race, F. M. Rowe, J. B. Speakman and T. Vickerstaff. *Tex. Mfr.*, May 1938, P. 211–12.

Damage to wool fibres by light and air is due to hydrolytic attack on the cystine linkages. Level dyeing can be obtained with either colloidal or crystalloidal dyes by modifying the dispersion. Unlevelness may develop or recur in afterchroming; a method to avoid this is described. (C)

IV. Research Methods and Apparatus

Cotton-fibre Models. Horst Reumuth. *Klepzig's Textil-Z.*, 1937, V. 40, P. 621–3; abs. in *C. A.*, 1938, V. 32, Col. 1464.

Microscopically true models are shown of various cotton fibres. (W)

Constituent Fibres in Mercerized Mixed Fabrics: Detection of. H. Bach. *Kunstseide u. Zellwolle*, 1937, V. 19, P. 395–400; abs. in *C. A.*, 1938, V. 32, Col. 1464.

While the components of unmercerized mixed fibres of cotton and staple rayon are easily distinguished by ordinary microscopic examn., the mercerized fibres resemble each other very closely. By examn. of the cross-sections, by tinting, or by controlled swelling this difficulty is overcome.

Mercerized viscose staple rayon and cotton are very different in cross-section; mercerized cuprammonium staple rayon is similar to cotton, but generally exhibits a characteristic concavity. Tinting also shows differences between cotton and staple rayon: I–KI solns. gave good results (*C. A., 31,* 6015); Zn chloroiodid tints staple rayon deep blue and cotton reddish, but the difference is not very marked with mercerized fibres unless they are viewed through a yellow filter. Immersion in 15° Be. NaOH solns. will cause strong swelling of viscose or cuprammonium staple rayon, but leave cotton almost unchanged. This difference is accentuated by tinting with Victoria Blue B; the cotton retains a blue or deep-red color, while the over-swollen staple rayon is almost colorless. (W)

ELECTRICAL DETERMINATION OF THE MOISTURE CONTENT OF WOOD. P. M. Flier. *Siemens Z.*, 1937, V. 17, P. 541–5; abs. in *C. A.*, 1938, V. 32, Col. 1447.

An improved instrument is described embodying a variable d.-c. supply, and a small Ne lamp as indicator. (W)

EXAMINING YARNS AND TEXTILE FABRICS: SIMPLE METHODS OF. H. Schneider. *Deut. Textilwirt.*, 1937, V. 4, No. 20, P. 41–5; No. 21, P. 41–6; abs. in *C. A.*, 1938, V. 32, Col. 1461.

The following tests are described and the results obtained with various types of yarns and textile fabrics are given: Combustion, alkali, acid Pb $(AcO)_2$, tearing test, light test for thickness, oil, dyeing procedure using methylene blue for differentiating cotton from linen, differentiation of various rayon yarns and fabrics, differentiation of fabrics by means of neocarmin and pierocarmin, differentiation of cotton from German shoddy; detn. of various phys. properties, test for wearability and resistance to rubbing; detn. as to whether the dyeing was carried out on the flake, yarn or piece goods; detn. of the fastness of the dyeing to light, washing, boiling and alkalies. (W)

FIBRE MIXTURES: ANALYSIS BY REGAIN DETERMINATION. Q. Fimiani. *Textilia*, 1937, V. 13, P. 207–11; abs. in *J. T. I.*, Feb. 1938, P. A99.

The author suggests the determination of the weight of 1 gm. of dry fibre after conditioning at 65% R.H. as a means of analyzing mixtures. A table is given of conditioned weights for mixtures of cotton and other fibres, based on accepted regains, starting from 0 parts of cotton per 1,000 and rising by 50's to 1,000. The relationships are also expressed in a nomogram. (C)

pH DETERMINATION IN THE RAYON INDUSTRY. F. Schroeder. *Kunstseide u. Zellwolle*, 1937, V. 19, P. 278–80; cf. *C. A.*, 1937, V. 31, Col. 3702; abs. in *C. A.*, 1938, V. 32, Col. 1104.

Some new types of app. for the detn. of the pH and their application in the rayon industry are described. (W)

PHYSICAL AND CHEMICAL TEXTILE TESTING. VII. John H. Skinkle. *Am. Dye. Rptr.*, Mar. 21, 1938, P. 144–6, 160–4.

Describes methods and apparatus for the strength and stretch testing of fibres, yarns and fabrics. (C)

PROCESSING OPERATIONS IN THE TEXTILE INDUSTRY: SCIENCE AS A PACE MAKER IN. W. Weltzien. *Spinner u. Weber*, V. 55, No. 44, P. 23; *Deut. Textilwirt.*, V. 4, No. 20, P. 3–4 (1937); abs. in *C. A.*, 1938, V. 32, Col. 1461.

A review covering (1) the formation of fibres, (2) studies of phys. properties (time/tension curves; diagrams of state in relationship to load, tension and time, and space models), (3) anisotropy of textile fibres (influence of colloidal state of artificial fibres on mech. properties), (4) the colloidal nature of the changing water absorption power of textile fibres at different air humidities, (5) finishing problems of staple rayon and (6) the testing of the finished product. (W)

(FROM) RAYON TO STAPLE RAYON. G. Nitschke. *Monatschr. Textil-Ind.*, 1937, V. 52, Fachheft II, P. 39–42; abs. in *C. A.*, 1938, V. 32, Col. 1462.

The manuf. of staple rayon is reviewed. Various types of staple rayon can be distinguished from another by dyeing with Neocarmin W which yields the following colors: acetate staple rayon, light greenish yellow; viscose staple rayon, wine-red; Cu staple rayon, dark blue; cotton, light blue; linen, lilac; wool, yellowish green; degummed silk, old gold; nondegummed silk, dark greenish black. Two samples of mixed staple rayon fabrics are shown. (W)

STAPLE RAYON: TESTING OF—BEFORE PROCESSING. A. Jaumann. *Kunstseide u. Zellwolle*, 1937, V. 19, P. 373–5; abs. in *C. A.*, 1938, V. 32, Col. 1463.

Tests on staple rayon must be more exhaustive and systematic than on cotton or wool. J. deseribes a no. of rapid, easily performed tests which do not require extensive equipment. (W)

STAPLE RAYONS: MEASUREMENT OF THE LONGITUDINAL SWELLING OF. II. W. Weltzien and C. Faust. *Monatsh. Seide Kunstseide*, 1937, V. 42, P. 481–6; abs. in *C. A.*, 1938, V. 32, Col. 1463.

Various types of staple rayons were examd. for longitudinal swelling on exposure to dry air, water, dry air, water, 6% NaOH by vol., dil. AcOH, water, dry air, water, dry air. The change in length during the immersion in NaOH varies greatly but is very characteristic for different types of staple rayon. With staple rayon a considerable increase in length takes place, while viscose staple rayons may either increase or decrease in length. Numerous swelling diagrams are presented. Titer deviations and deviations of the longitudinal swelling are completely independent of another. Longitudinal swelling is closely related to elongation and dyeing properties. (W)

TEXTILE FIBRES: NEW METHOD FOR DETERMINATION OF THE WIDTH SWELLING OF. P. Eckert. *Klepzig's Textil-Z.*, 1937, V. 40, P. 638–9; abs. in *C. A.*, 1938, V. 32, Col. 362; *J. T. I.*, Feb. 1938, P. A100.

By means of a specially designed app. width measurements are made before and after exposure of the textile to a swelling medium. The following typical results are obtained in percentage of width swelling: Australian wool 13.3; German wool 14.4; silk 8.0; com. viscose fibres I–IV 38.0, 38.9, 40.8 and 34.0; com. Cu staple rayon I–II 41.1, 41.4; special viscose staple rayon 1–4, 29.9, 28.9, 31.7 and 34.1. (W)

TEXTILE FIBRES: SWELLING. P. Eckert and K. Hoinkis. *Papier-fabrik.*, 1937, V. 35, *Techn.*, P. 441–3; abs. in *J. T. I.*, Feb. 1938, P. A100.

Apparatus of the volumenometer type for measuring the change in volume of textile fibres, fabrics and similar materials on swelling is described and the results of measurements of the change in volume of wool, silk, cotton, cuprammonium and viscose rayon, and staple fibres and impregnated viscose rayon fabric on swelling in water are given. The highest increases are shown by viscose rayon and staple fibre and the lowest by silk and wool. The impregnated viscose rayon fabric has a much lower swelling power than the untreated viscose fibre. (C)

TEXTILE OILS: GENERAL EXAMINATION OF. J. Barritt. *J. Huddersfield Text. Soc.*, 1936–1937, P. 70–7; abs. in *J. T. I.*, Jan. 1938, P. A9.

The methods used in the examination of textile oils are discussed and their limitations emphasized. The use of absorption spectra for the detection of teaseed oil is illustrated and the effect of anti-oxidants on oxidation tests of oils discussed. (C)

V. ECONOMICS, PHYSICS AND MISCELLANY

AMYLASES: ACTIVITY. J. Blom, A. Bak and B. Braae. *Z. physiol. Chem.*, 1937, V. 250, P. 104–22; abs. in *J. T. I.*, Feb. 1938, P. A112.

A useful review is given of problems connected with the individuality of the various amylases, including methods for testing amylase activity, differentiating between α- and β-amylases, the overlapping of the effects ascribed to these forms, and conditions under which activity is impaired. Original measurements of activity towards potato starch are recorded as determined from (a) iodimetric titration of reducing power, (b) viscosity of starch paste, and (c) iodine color of starch paste. (C)

CELLULOSE: EFFECT OF SODIUM SULPHIDE AND SALT SOLUTIONS ON VISCOSITY. K. Seki, S. Kobinati and H. Ishikawa. *J. Soc. Chem. Ind., Japan*, 1937, V. 40, P. 382–4B; abs. in *J. T I.*, Feb. 1938, P. A66. (C)

Book Reviews

AMERICAN WOOL HANDBOOK. Werner von Bergen and Herbert R. Mauersberger. First Edition, 864 pp. Illustrated. American Wool Handbook Co., New York, N. Y. Price $3.95 in U. S. A. and Canada, $4.75 in other countries.

This is a much needed reference book, written in simple and easily understandable English, reflecting primarily American technique in the conversion of wool into yarns and fabrics. It consolidates existing old and much new information concerning the growing of wool, its marketing, grading and use in the woolen and worsted trade. Both authors have had many years of practical experience in the woolen and worsted trade in this country and abroad. Mr. von Bergen is chief chemist of the Forstmann Woolen Co., Passaic, N. J., and has been teaching wool manufacture at Columbia University. Mr. Mauersberger is technical editor of *Rayon Textile Monthly* and for many years has been in charge of the evening textile courses at Columbia University.

The preface to the book is written by Arthur Besse, president of the National Association of Wool Manufacturers. He states that "the book will fill a long felt need and will provide the trade with a valuable and authoritative reference book on all phases of wool production and manufacture."

The contents are logically arranged, beginning with a history of the wool trade, the economic and statistical side of the business, sheep raising and wool growing, physical and chemical properties of wool, grading and marketing. The various manufacturing operations are covered in detail, and there are separate chapters on the manufacture of carpets, rugs and plushes by W. T. Harrison and G. E. Hopkins of Bigelow-Sanford Carpet Co.; on felt manufacture by R. K. Brooks of Chas. W. House & Sons, and a chapter on dry cleaning by C. C. Hubbard, director of the Dry Cleaning and Redyeing School. There is a chapter on physical and chemical testing, a very complete glossary of trade terms, a reference list of American and foreign literature, a very complete dyestuff appendix, and an unusually well-done subject index. (C)

MECHANICAL CHANGES IN THE WOOLEN AND WORSTED INDUSTRIES, 1910 TO 1936. Boris Stern. 36 pp., illustrated. For free copy, address Corrington Gill, Assistant Administrator, W. P. A., Washington, D. C.

This is the report on a joint survey by the National Research Project of the W. P. A. and the Bureau of Labor Statistics, conducted by research workers and statisticians taken from relief rolls. A similar study was made previously in the cotton textile industry. The data on changes in machinery and the labor requirements presented in the report were prepared in collaboration with the Barnes Textile Associates, Inc., Boston, Mass. Boris Stern of the Bureau of Labor Statistics, economist in charge of the study, summarizes the findings as follows:

"The effect of the utilization of the most advanced textile machinery on the market in 1910 is to increase considerably the man-hour output in manufacturing the two woolen and the two worsted types of cloth covered by this survey. Barely half as much labor time would have been required in 1936 to produce a given amount of woolen and worsted cloth as was required with advanced technology in 1910. For the departments covered in this study, the increase in possible man-hour output between 1910 and 1936 was 86.4% in the manufacture of 32-ounce overcoating and 87.5% in 12-ounce woolen flannel. (These were the two types of cloth studied in the woolen industry.) Among the worsted products (worsted serge and cotton-warp worsted-filled suitings), the increase in the man-hour output between 1910 and 1936 was 86.3% in worsted serge and 87.5% in cotton-warp worsted-filled suiting. As a result of this increased labor productivity, the man-hour requirements to produce an equal yardage of woven woolen and worsted cloth in 1936 showed a marked decline, averaging about 46.5% for the two woolen and two worsted products covered by the study." (C)

STATISTICAL STUDY OF WOOL PRICES. Thomas R. Hamilton. 56 pp., illustrated. A. and M. Press, College Station, Texas. Price, 75 cents postpaid.

A statistical study of the economic laws of supply and demand with special application to wool prices. Quantitative measurements of the principal factors affecting the price of wool. (C)

VERTICAL INTEGRATION IN THE TEXTILE INDUSTRIES. Hiram S. Davis, George W. Taylor, C. Canby Balderston, Anne Bezanson. 144 pp. Industrial Research Dept., Wharton School of Finance and Commerce, 3440 Walnut St., Philadelphia, Pa. Price, $1.50.

Although this is the second of three researches that have been organized by U. S. Institute for Textile Research, this is the first to be completed and published. It is an outstanding example of the possibilities, for an industry made up of a large number of relatively small units as is the textile industry, of co-operative research. This study was suggested, promoted, organized and placed by the Institute's Committee on Economic Research, and the latter with the heads of three leading textile associations acted as an advisory committee during its conduct by the Wharton School of Finance and Commerce of which Dr. Joseph H. Willits is director. Its financing in large part by a grant of The Textile Foundation for two years was largely responsible for the early completion of the study, whereas the Institute's two other studies, which are technical, have had to be wholly or partially refinanced each year. In the conduct of this economic study the directors have not only had the benefit of the co-operation mentioned, but of that of 20 other trade associations, all of which receive credit in the preface to the report.

Vertical Integration in the Textile Industries is a study of the experiences of several hundred companies. It brings together and interprets these experiences to show how vertical integration has worked at each major marketing stage from yarn to retailing and for the principal classes of textile products. Included among the companies studied were yarn producers, weavers, knitters, finishers, converters, garmemt manufacturers, wholesalers, and retailers. Both the advantages and the disadvantages of the vertically organized company are discussed. But the report does not stop here. Some companies have integrated under favorable conditions and failed; others have integrated against severe odds and succeeded. In many such cases, an important factor has been the way in which the integration program was undertaken. This report sets forth the policies and techniques which have been found most effective in overcoming or minimizing the obstacles usually encountered by the vertically organized company. Consideration is given not only to integration by direct means but also to integration by indirect methods. A firm can integrate outright through investing in additional facilities, or it can avoid such investments and still bridge a market. It may have work done on commission, or it may undertake a program of brand promotion. Those companies which now promote brands to the consumer or which contemplate such a program will find Chapter VII of particular interest. It deals with the possibilities of bridging the so-called "gap" between mill and consumer by means of brand promotion. Integration is not treated as a panacea for the ills of the textile industries in this report. Rather it is presented as a form of organization that can provide distinct benefits wherever the obstacles are not great or can be overcome by a resourceful management. Every executive in the textile or related industries and trades should find "Vertical Integration in the Textile Industries" a valuable guide in appraising the business organization of his own company. This study enables each executive to share in the experiences of those concerns which have tried integration. (C)